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METHOD FOR THE DYNAMIC INHALATION INOCULATION OF ANIMALS WITH HYGROSCOPIC DUSTS

[Following is the translation of an article by I. F. Boyarchuk, Institute for Industrial Hygiene and Occupational Diseases, AMN, USSR, published in the Russian-language periodical Farmakologiya i Toksikologiya (Pharmacology and Toxicology) 26(3), 1963, pages 377-381. It was submitted on 26 Feb 1962.]

In connection with the wide dissemination of new types of mineral fertilizers, especially complex nitrogen fertilizers, special significance is being acquired by a study of their toxicity, since a considerable contingent of people come in contact with them: in production, transportation, storage, agriculture, etc. The process of production of complex fertilizers consists of the acid decomposition of phosphorites for the conversion of phosphorus from a bound state into a form which is assimilable by soil. The resulting product, just as all the other forms of mineral fertilizers, is a highly hygroscopic substance - a nitrogen-phosphorus-potassium fertilizer - and when applied to the soil is dissolved easily.

During the process of technological production of complex fertilizers there is considerable contamination of the air in the industrial premises by highly dispersed aerosols of raw material and finished product which contain fluorides and have an unfavorable influence on the health of the workers.

For a toxicological study of complex fertilizers and determination of maximum permissable concentrations of aerosols of nitrophosk [fertilizers containing N, P, K] it was necessary to study the chronic action of this substance on animals under conditions of dynamic inhalation poisoning.

Methods which were used earlier for creation of concentrations of solid aerosols under conditions of dynamic poisoning of animals were based on the use of products with weak hygroscopic properties and which dispersed easily. Attempts to use available methods for creating persistent concentrations of aerosols of nitrophosk in chambers were unsuccessful.

The purpose of our investigations was the development of a method for the creation of persistent levels of concentrations of aerosols in poison chambers for highly hygroscopic substances, which is what complex nitrogen fertilizers are.

As the source of supply of air into the chamber we used a centrifugal high-pressure ventilator, which was capable of the simultaneous supply of 5—6 six-hundred or 20—25 one-hundred liter poison chambers and which had doubtless advantages over the widely used Gubkin blowers. Among the deficiencies of the stated ventilator it is necessary to include the noise created by it during operation. In order to eliminate it it was necessary to apply hermetic sealing or to move the ventilator into a separate accomodation.

For dispersion of the substance we selected the vibration sprayer of the Yu. G. Shirokov system (1960), which creates persistent concentrations of aerosols of weakly hygroscopic substances. However, in operations a number of deficiencies were noted which influenced its work.

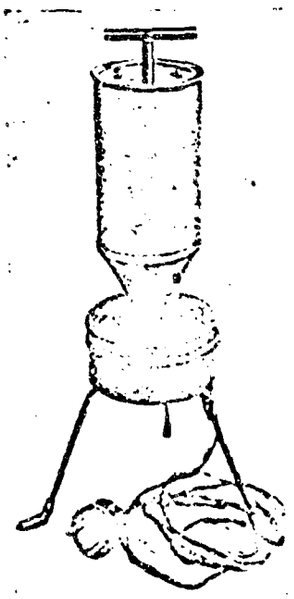

Figure 1. External view of the modified vibration sprayer of the Yu. G. Shirokov system.

1. During operation of the sprayer, as a result of collision of the support plates of the hopper with the supporting frame and of the core with the body of the induction coil a noise is created which reaches a considerable magnitude during the simultaneous operation of several sprayers.

2. The difficulty of constant maintenance of the same parameters of vibration of the bunker of the sprayer as a result of amortization of the vibrating plates of the body requires constant control of the operation of the device, since in the opposite case a considerable fluctuation is noted in the levels of concentrations in the chambers.

For the purpose of eliminating these dificiencies the sprayer was modified (Figure 1). As a result of replacement of the vibrating plates by rubber packing with an increase of mass of the body of the induction coil the sprayer began to operate completely free of noise and with constant higher parameters of vibration of the body, which made it possible to create persistent levels of concentration of aerosols. Besides this the increase in the parameters of vibration of the body of the sprayer causes the vibration of the rubber hoses which are feeding the aerosol into the chamber and thus prevents their clogging.

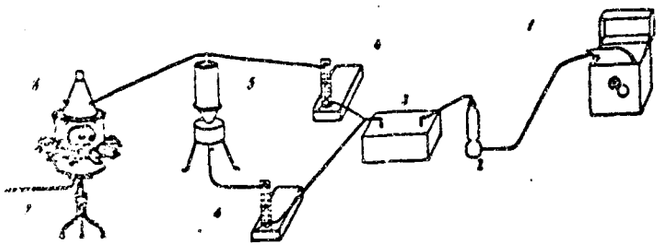

Figure 2. Diagram of the dynamic inhalation poisoning of laboratory animals with hygroscopic aerosols.

1. Centrifugal high-pressure ventilator; 2. Silica gel; 3. Heating element; 4. Anemometer; 5. Sprayer; 6. Chamber; 7. Exhaust hose.

For maintaining hygroscopic aerosols in a dry and easily volatile state we used the following system for drying the air (Figure 2.). Air being fed into the sprayer was preliminarily dried in coarse-grained silica gel with little resistance and then fed into an electro-heating element where it was completely dried and heated up to a temperature of 60—70°. The dry and heated air enters the sprayer (and the hygroscopic aerosol is constantly maintained in a dry and volatile state) and from here at a temperature of 20—25° is fed into the poison chamber. The temperature of the air entering the chamber of the sprayer can be changed depending on the hygroscopic state of the substance, temperature of the outside air, etc.

Finally we modified the Pravdin poison chamber, the design of which has significant deficiencies: 1) the impossibility of a differentiated study of the inhalation action of aerosols on the organism of animals, since the latter are simultaneously subjected to a cutaneous effect; 2) non-uniformity of concentrations of aerosols received by the animals as a result of their crowding together in the chamber and sorption of substance by their wool.

Table 1

Levels of concentrations of aerosols of nitrophosk in the chamber during dynamic inhalation poisoning (in mg/m³)

(b) Опыт	(a) Концентрации аэрозолей нитрофоски в пробах: (c) через 30 мин.	(d) через 1 час	через 2 часа	через 3 часа	через 4 часа	через 5 часов
1	48	52	56	49	53	58
2	250	263	278	285	271	280

Key: (a) Concentrations of aerosols of nitrophosk in samples; (b) Test; (c) in 30 minutes; (d) in 1, 2, 3, 4, and 5 hours.

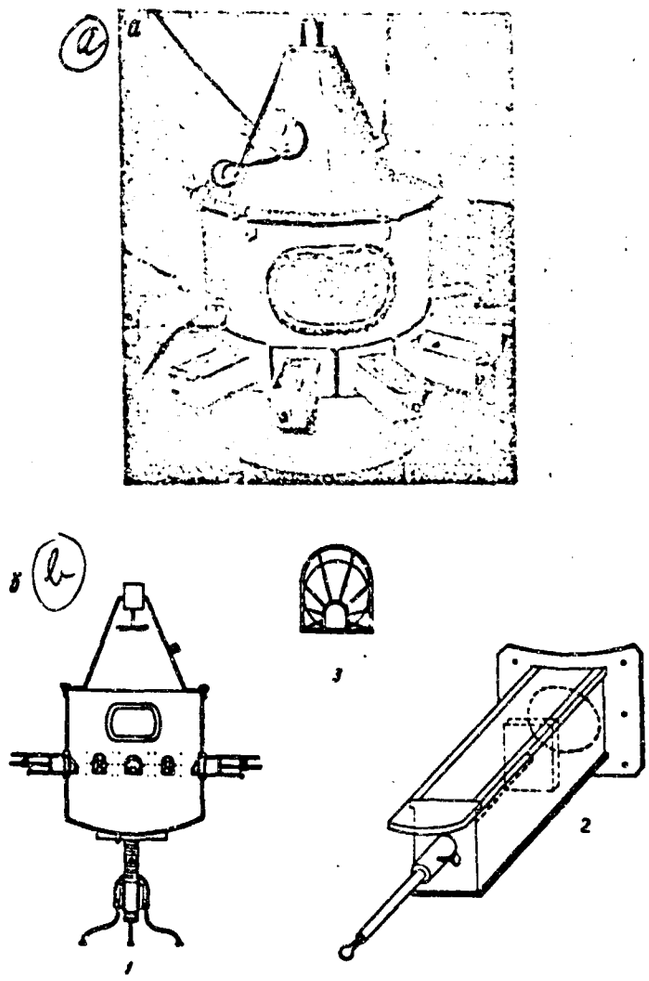

Figure 3. Chamber for the dynamic inhalation poisoning of animals. (a) - external view of the chamber; (b) arrangement of the chamber. 1 - chamber; 2 - booth for animals; 3 - cross section of booth.

Table 2

Results of a determination of concentrations of aerosols in a poison chamber by various methods (in mg/m^3)

(a) Время отбора проб	(b) Отбор стеклянной трубкой			(c) Непосредственно в камере			(d) Контроль вмонтированным в стенку камеры патроном		
	1	2	3	1	2	3	1	2	3
(e) Через 1 час	30 мг/м³	125 мг/м³	9,8 мг/м³	54 мг/м³	190 мг/м³	15 мг/м³	46 мг/м³	200 мг/м³	12 мг/м³
(f) Через 3 часа	32 »	150 »	10,3 »	40 »	200 »	13 »	36 »	170 »	13,2 »
(g) В среднем за сутки	31 » 74%	137 » 70%	10,1 » 72%	42 » 100%	195 » 100%	14 » 100%	41 » 97%	187 » 96%	12,6 » 90%

Key: (a) Time sample was taken; (b) Sampling with a glass tube; (c) Directly in chamber; (d) Control with holder mounted in the wall of the chamber; (e) in 1 hour; (f) in 3 hours; (g) Average daily.

Note: The Cyrillic designations are mg/m^3.

The types of poison chambers with separate booths which were used also have deficiencies: a) the booths are found on different levels of the poison chamber, where the concentrations of toxic substances are different; b) as a result of irrational construction of booths the animals are found in them in a constrained position and it is impossible to control their behavior during the process of poisoning. All the known types of poison chambers have a hexahedral form, which also hinders the creation of persistent levels of concentrations of aerosols in them as a result of the formation of eddies of air currents.

Our proposed construction (I. F. Boyarchuk and V. A. Lutov, 1961) of a 100-liter poison chamber for the dynamic inhalation poisoning of animals with toxic substances (Fig. 3) is a hollow cylinder of a conical form with a bottom and hood. Height of the cylinder is 500 mm and the diameter is 500 mm. On the outside along the middle line of the chamber there are 15 booths for the individual housing of animals. The booths have the form of a pencil box with top and bottom sliding covers made from organic glass for the housing of animals , control of their behavior, and convenience of removal. On the inside of the chamber the booth ends in a removable funnel made from metallic grating for the snout of the animal. In the booth a rod with a plate ensures that the snout of the animal is found in the grating, i.e., inside the chamber. The dimensions of the booths depend on the type of animal being poisoned. In the case of inoculating white mice the dimensions of the booth should be: length 150 mm, width 60 mm, and height 60 mm. For convenience of work the chamber is mounted so it rotates on its axis.

The method developed by us for the dynamic inhalation poisoning of animals with hygroscopic dusts made it possible in poison chambers of the new construction to create persistent levels of concentrations of aerosols of nitrophosk for the dynamic poisoning of animals. The results of the tests are given in Table 1.

Resulting data show that with the help of the proposed method of dynamic inhalation poisoning it is possible to create persistent levels of concentrations of aerosols of highly hygroscopic substances in the poison chambers. The proposed design of a chamber promotes the maintenance of concentrations of substances during the process of poisoning.

Control of the levels of concentrations of aerosols was done by means of FPP-15 filters according to the method advanced by the Institute of Work Hygiene and Occupational Diseases, AMN USSR. However, a check showed that the concentrations of aerosols, obtained by means of taking of samples through glass intake tubes, differed considerably from the concentrations which were obtained by the direct taking of samples in the chamber as a result of settling of aerosols on the glass tube, rubber hose, dust holder, etc. (Table 2).

As can be seen from Table 2, 26—30% of the aerosols settles in the intake tubes and noses. In connection with this we proposed the intake of samples directly from the zone in the chamber where the animal is breathing with the help of a dust holder mounted in the wall of the chamber. As investigations showed, under these conditions of taking samples of air the concentrations corresponded to those inside the chamber.

Conclusions

1. Existing methods of inhalation poisoning of animals do not permit the creation of uniform concentrations of aerosols of highly hygroscopic substances.

2. For the creation of the required levels of concentrations of hygroscopic aerosols in poison chambers a method of inoculation is proposed which includes a system for the drying and heating of air being fed into the chamber.

3. The modified sprayer of the Yu. G. Shirokov system improves the spraying of hygroscopic aerosols and makes it possible to create uniform concentrations of aerosols in the chamber.

4. For the inhalation poisoning of animals a chamber with individual booths is proposed. This excludes the cutaneous action of the aerosols and ensures uniform levels of concentrations of aerosols.